Long-Term Demonstration of Sorbent Enhancement Additive Technology for Mercury Control

Kickoff Meeting

DOE NETL

Morgantown, WV

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Energy & Environmental Research Center

Presentation Outline

- Technology Introduction
- Past Experience
- Sites for this Study
  - Hawthorn Unit 5 (Kansas City Power & Light)
  - Mill Creek Unit 4(Louisville Gas & Electric)
- Test Plan for HAW 5
- Test Plan for MC 4
- Schedule

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Sorbent Enhancement Additive (SEA) Technology

- SEA1 (B&W/Niro, U.S. patent 5,435,980)
  - Chloride added to coal feed.
  - Hg capture can be enhanced with carbon.
- SEA2 T2
  - Added upstream of the particulate control device.
  - Carbon treated in situ.
  - Tailored to desired Hg removal.

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History of SEA2 Technology

- First testing done on ND lignite with SEA2 addition in coal.
- Later lignite tests involving co-addition with PAC in to PCD to be more effective (SEA2-T2).
- Pilot-scale projects with PRB (injection with coal) showed promise.
- Large-scale tests at Hawthorn and Hoot Lake validated SEA2-T2 effectiveness for PRB.
- All future tests conducted with SEA2-T2.

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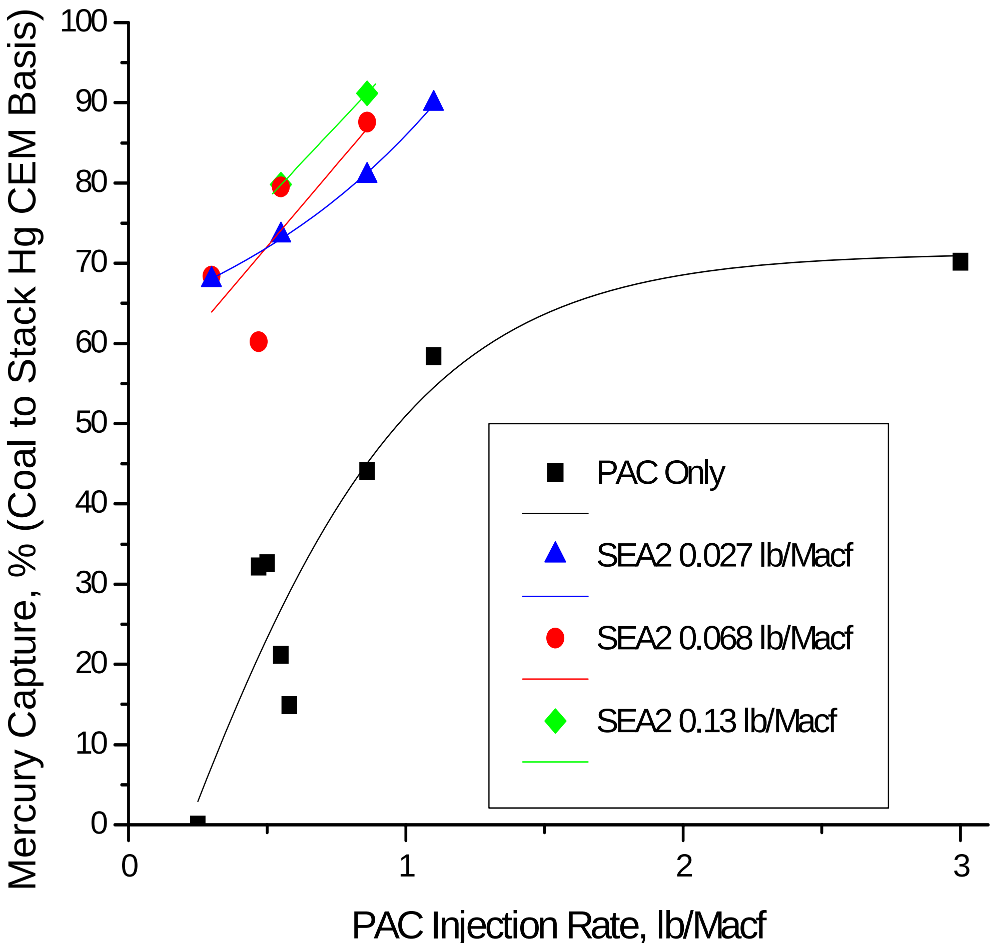
North Dakota Lignite SDA–FF



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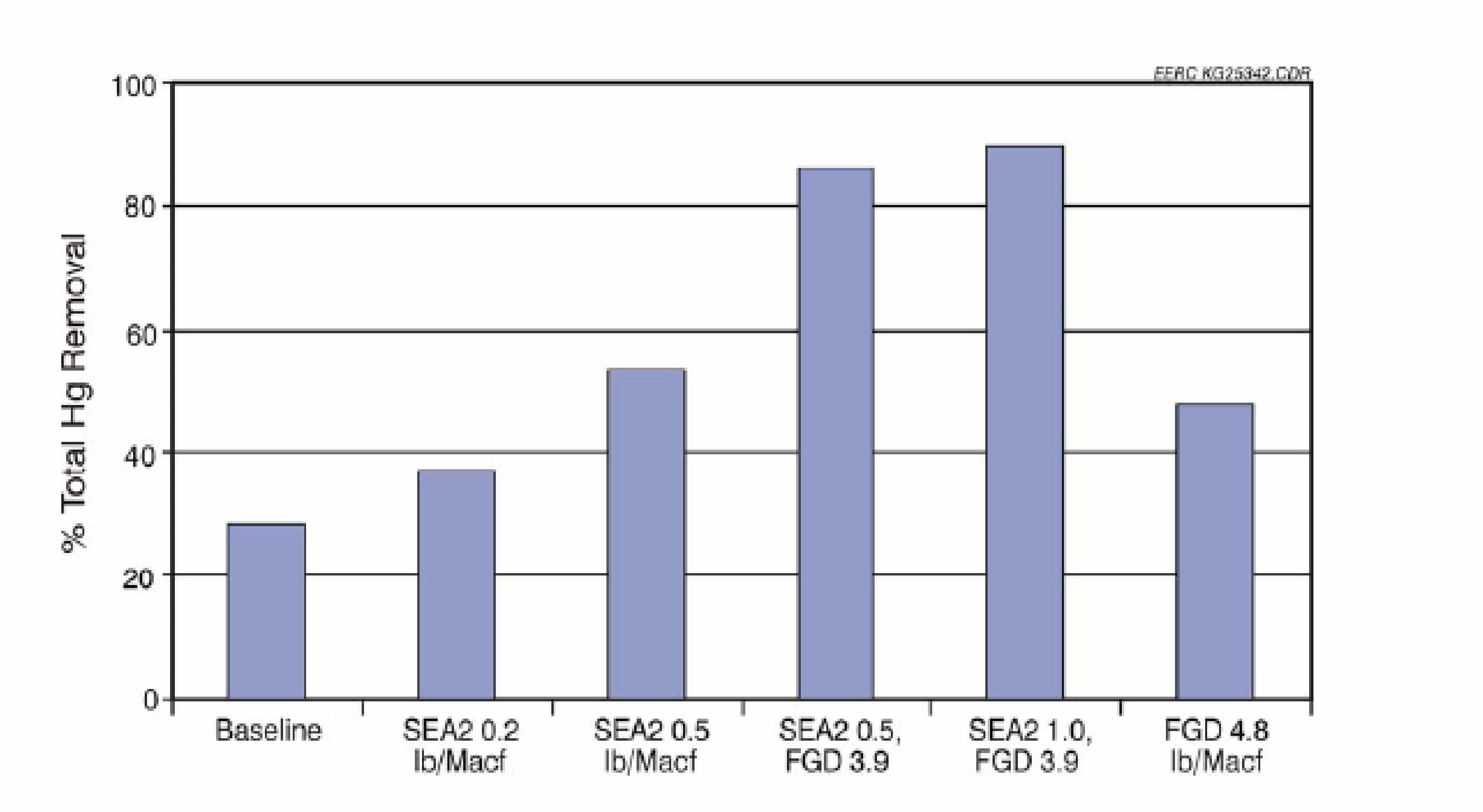
Pilot-Scale SDA-ESP, PRB



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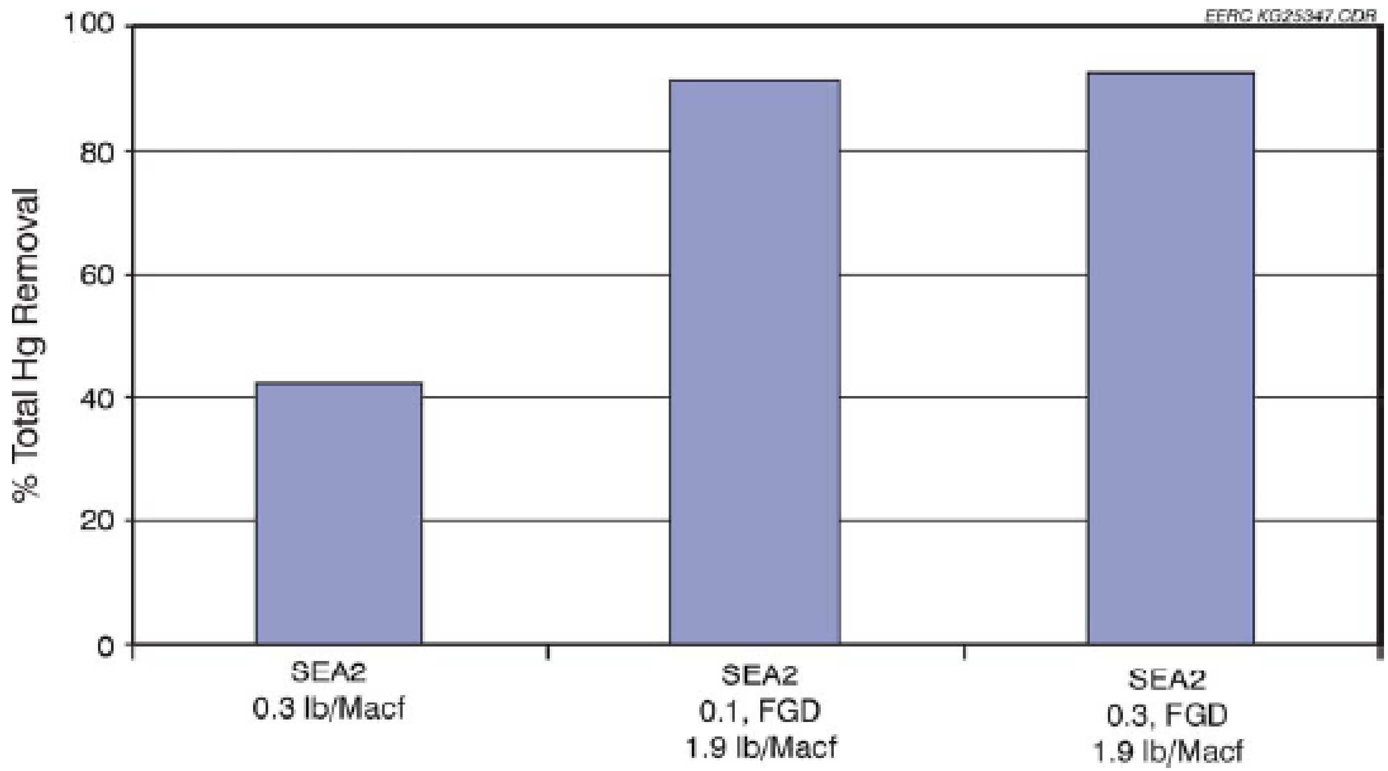
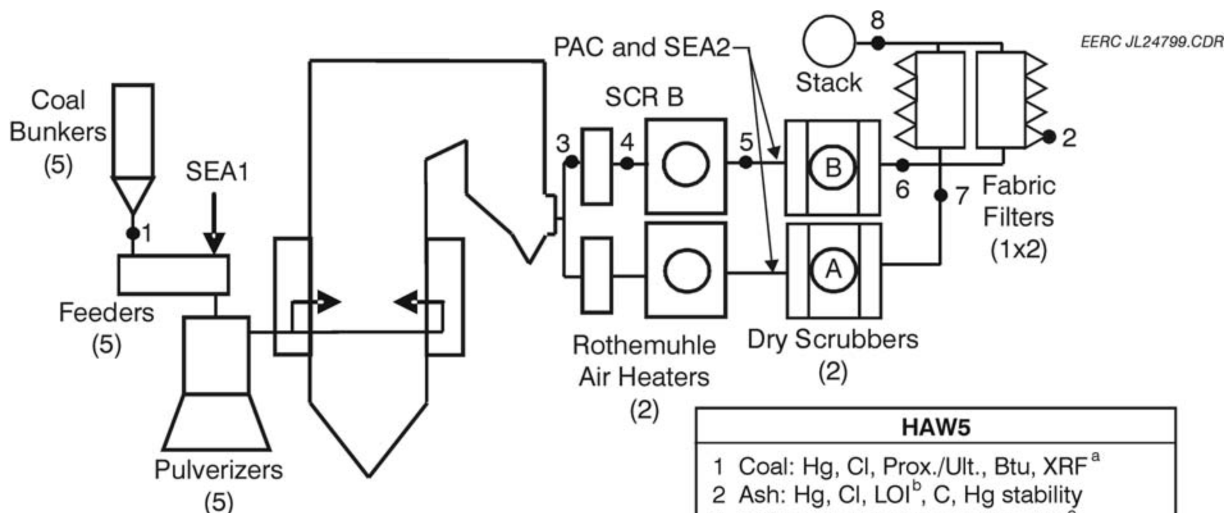
Pilot-Scale SDA-FF, PRB



Hawthorn Unit 5



HAW5
1 Coal: Hg, Cl, Prox./Ult., Btu, XRF[a]
2 Ash: Hg, Cl, LOI[b], C, Hg stability
3 SCR B Inlet Flue Gas: OH, HCl[c]
4 SCR B Outlet Flue Gas: OH
5 SDA B Inlet Flue Gas: OH, CMM
6 SDA B Outlet Flue Gas: OH, CMM, HCl[d]
7 SDA A Outlet Flue Gas: OH, CMM, HCl[d]
8 FF Outlet Flue Gas (stack): OH, CMM

[a] X-ray fluorescence.
[b] Loss on ignition.
[c] HCl between SCR layers (Cormetech), Tests 1–4.
[d] HCl Test 7.

Coal, Hg/Cl Analysis

	Mercury		Chlorine	
Date	µg/g	lb/TBtu	µg/g	lb/TBtu
7/11/2005	0.0852	7.32	6	515.82
7/12/2005	0.0955	8.20	6	515.24
7/14/2005	0.0996	8.53	7	599.73
7/15/2005	0.114	10.00	6	526.45
7/15/2005	0.0922	8.26	7	627.30
7/17/2005	0.0691	5.95	5	430.51
7/18/2005	0.0992	8.72	7	615.49
7/19/2005	0.111	9.64	6	521.10
7/20/2005	0.0956	8.38	7	613.87
7/23/2005	0.0659	5.76	6	524.61
7/24/2005	0.0711	6.31	9	798.51
7/25/2005	0.116	10.19	7	615.06
7/26/2005	0.0932	8.05	5	431.93

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Parametric Test Plan

Test No.	Hg Control Additive	Objective – Hg Reduction
1	None	Baseline
2	$CaCl_2$ only	400 ppmw in coal
3	$CaCl_2$ only	1000 ppmw in coal
4	PAC only	3 lb/Macf
5	PAC only	10 lb/Macf
6	$CaCl_2$ + PAC	250 ppmw, 3 lb/Macf
7	SEA2 + PAC	0.025 lb/lb, 3 lb/Macf
8	SEA2 + PAC	0.05 lb/lb, 3 lb/Macf
9	SEA2 + PAC	Vary SEA2 and PAC to determine maximum reduction
10	SEA2 + PAC	Extended test

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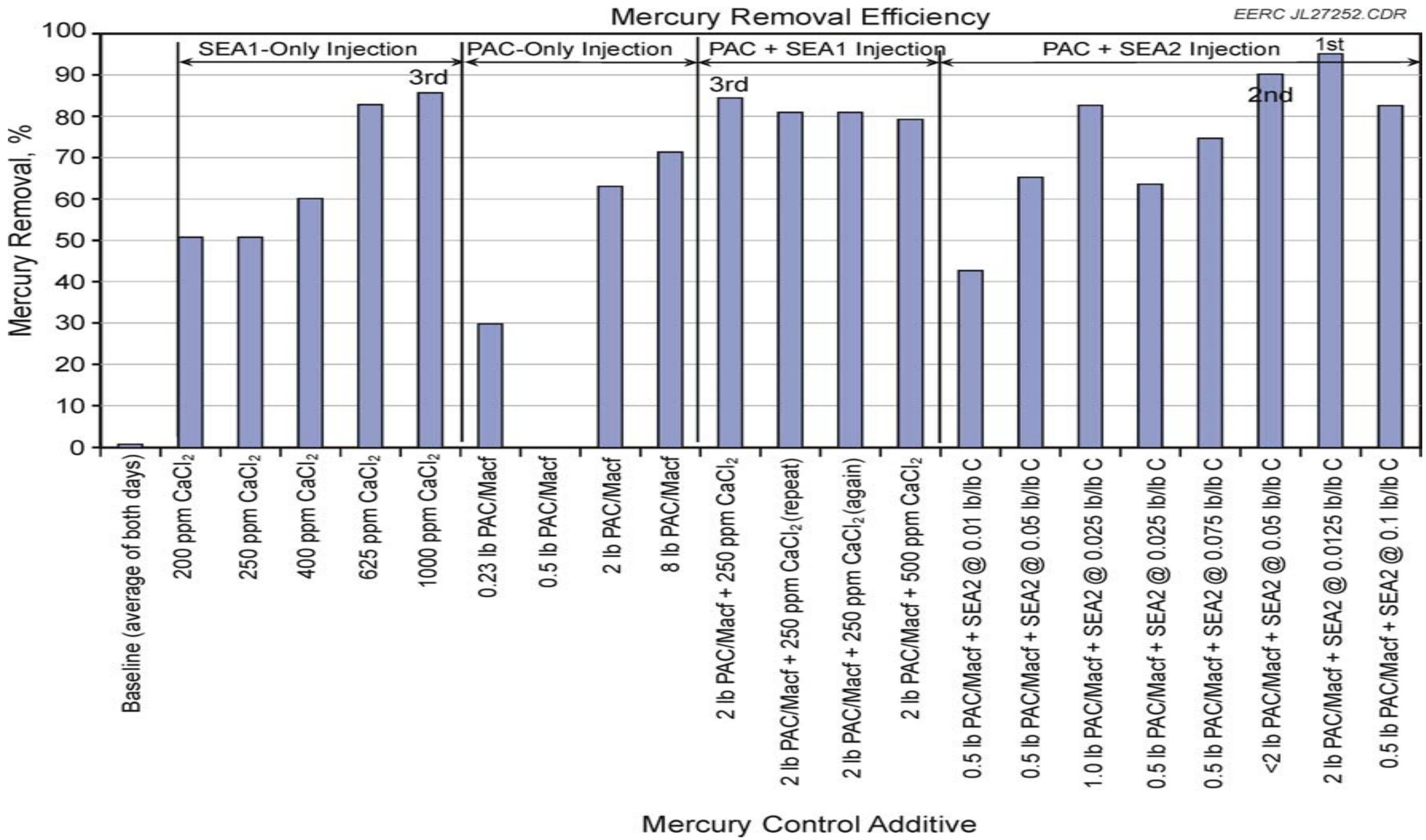
Hawthorn Test Results



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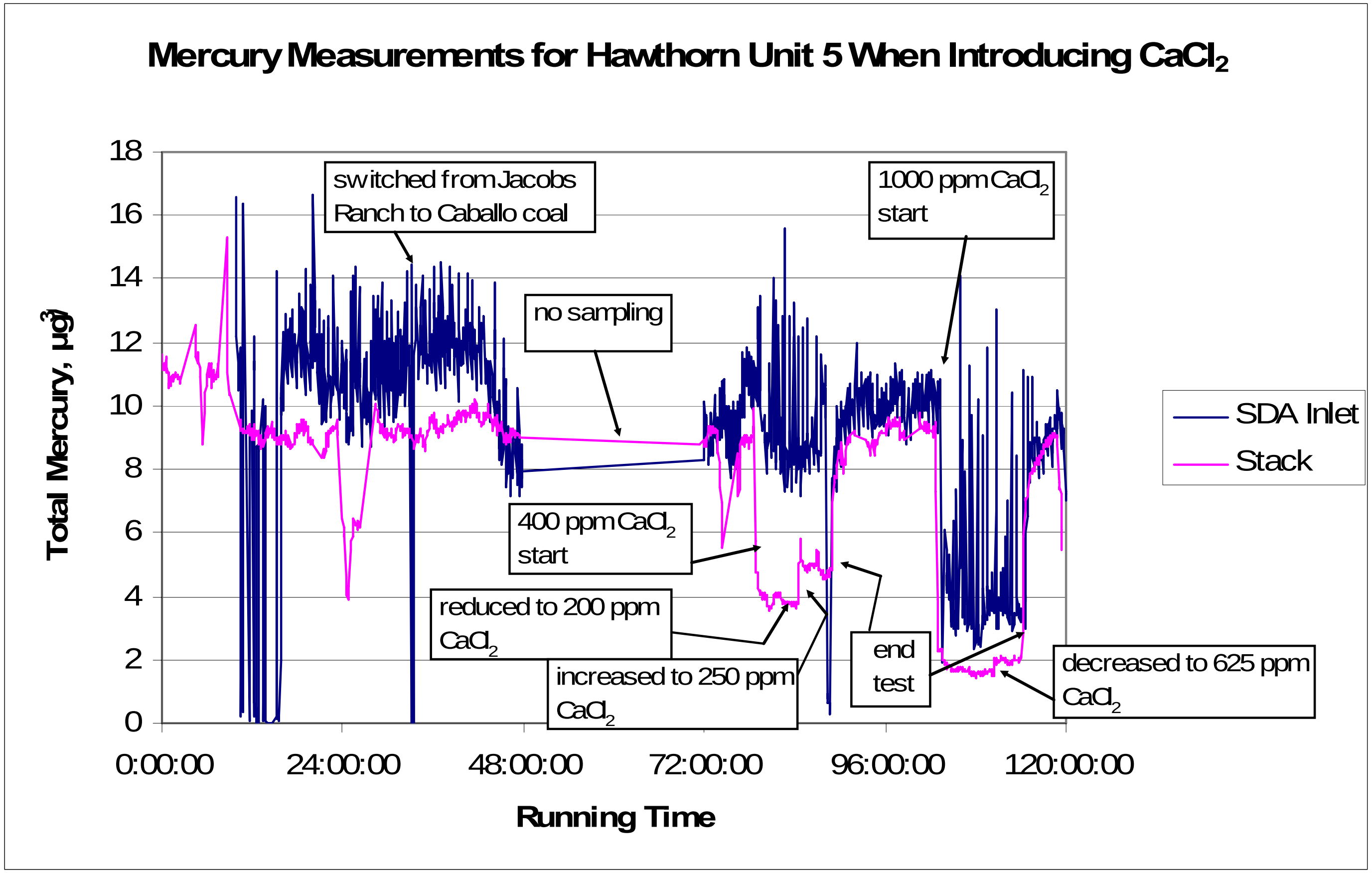
Hawthorn Test Results (SEA1)



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Dust Loading at SDA Inlet

Hg Control Additive	Dust Loading, ton/TBtu	Ash Mercury Concentration, µg/g	Particulate-Bound Mercury, lb/TBtu
Baseline[a]	1880.6	0.385	1.45
0.23 lb PAC/Macf	2720.1	0.494	2.69
2 lb PAC/Macf	1689.6	0.698	2.36
8 lb PAC/Macf	3121.7	1.213	7.57
2 lb PAC/Macf + 250 ppm $CaCl_2$ (average of two)	2120.4	0.74	3.14
0.5 lb PAC/Macf + SEA2 @ 0.05 lb/lb C	2320.5	1.199	5.57
0.5 lb PAC/Macf + SEA2 @ 0.025 lb/lb C	2363.4	1.197	5.66
<2 lb PAC/Macf + SEA2 @ 0.05 lb/lb C	2100	1.246	5.24
0.5 lb PAC/Macf + SEA2 @ 0.1 lb/lb C	2068.5	1.591	6.58

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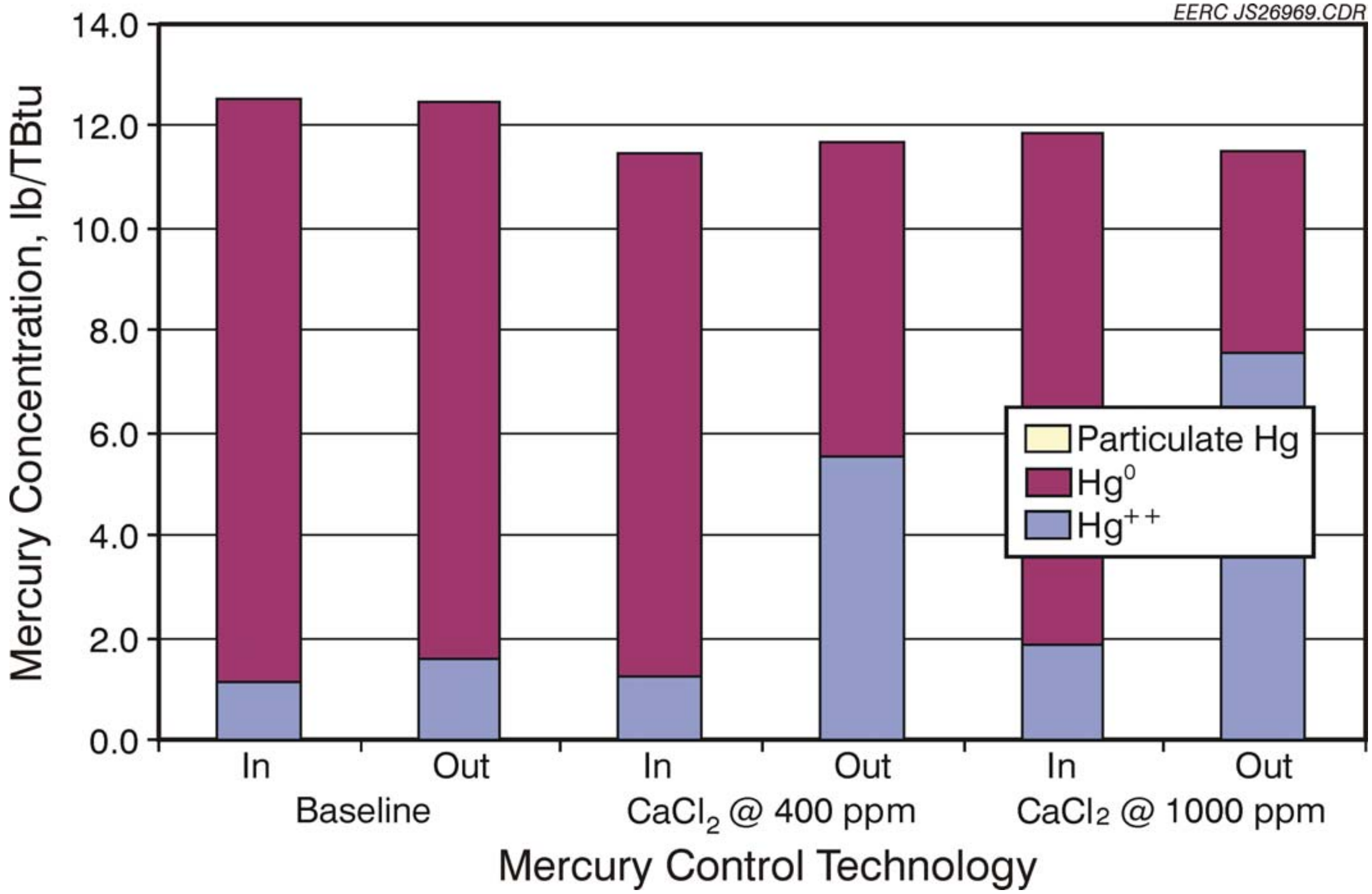
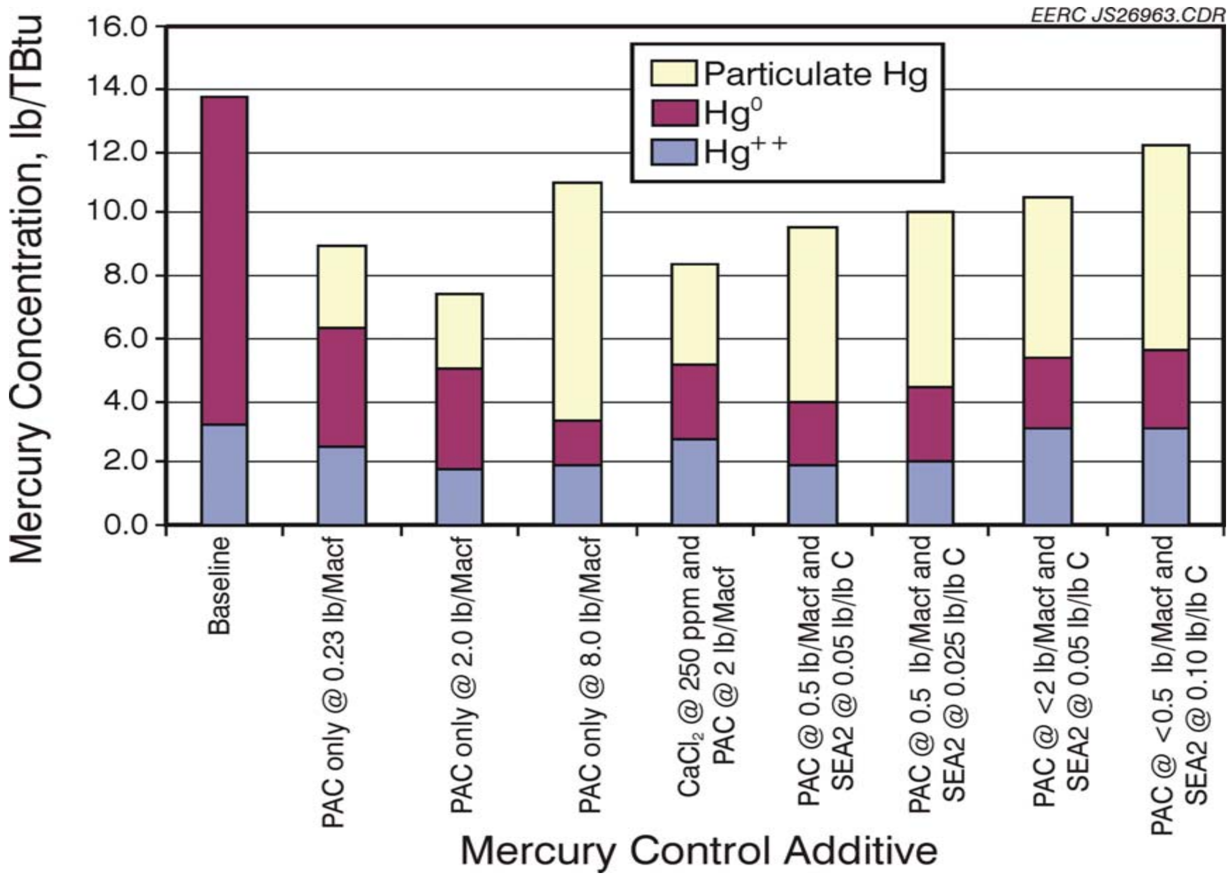
Hg Speciation at SCR Outlet



Hg Speciation at SDA Inlet



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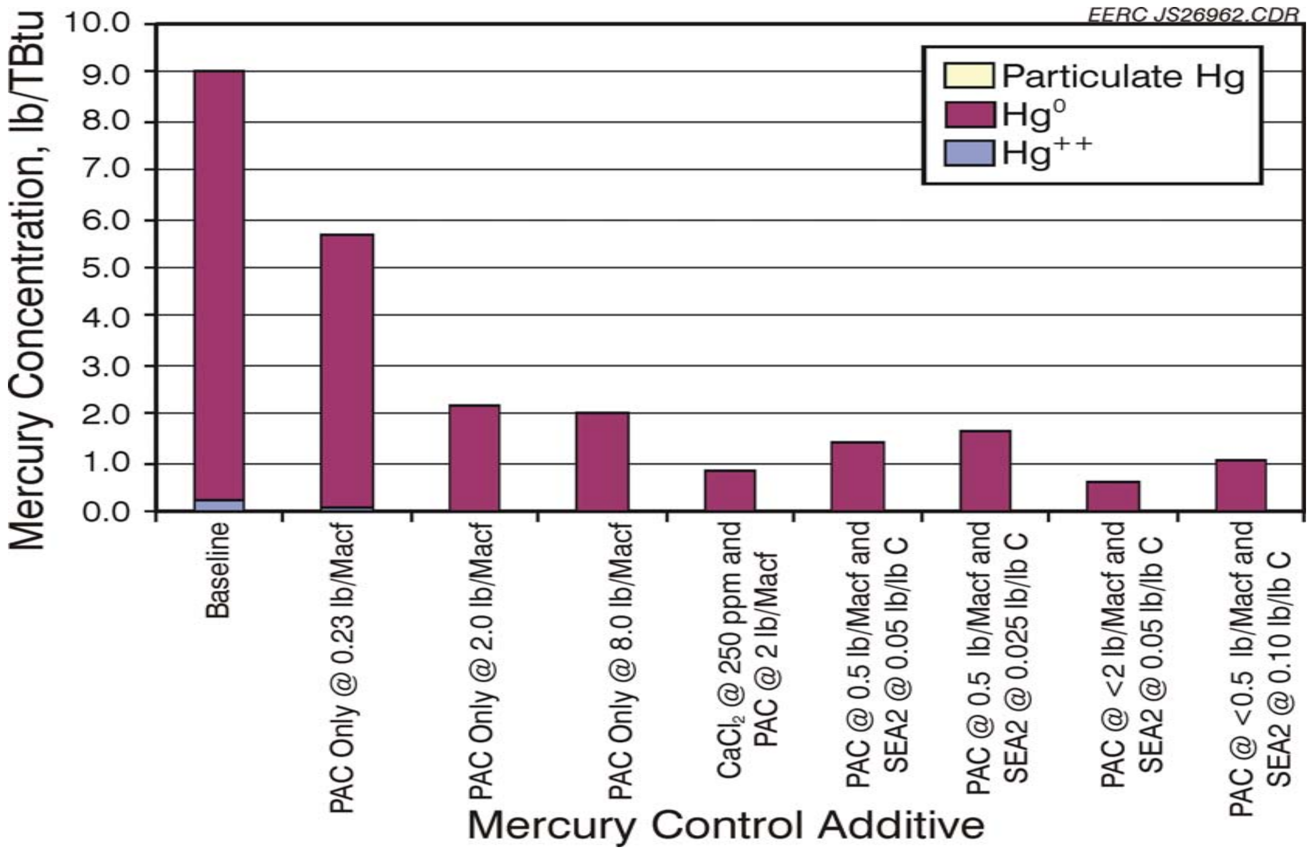
Hg Speciation at Stack



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Conclusions

- 1000 ppm Cl addition (no PAC) at Hawthorn provided an 80%+ Hg capture for 6 hours.
- >90% Hg capture was possible (for short periods of time) using SEA2 and PAC.
- >90% REDUCTION is possible with SEA2 T2 (SEA2 + PAC).

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Goals & Objectives

- To demonstrate 90% REDUCTION in mercury emissions at Hawthorn Unit 5 and Mill Creek Unit 4.

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Sites

Plant	Utility Owner	Coal	Boiler Type	Boiler Size, MW	Particulate Control	SO_2 Control	NO_x Control
HAW5	KCP&L	PRB	Wall-fired	550	FF	SDA	LNB[1], OFA[2], SCR
MC4	LG&E	Eastern bituminous	Wall-fired	530	ESP/SCA= 232	Wet FGD	LNB, SCR

[1] Low-NO_x burners.
[2] Overfire air.

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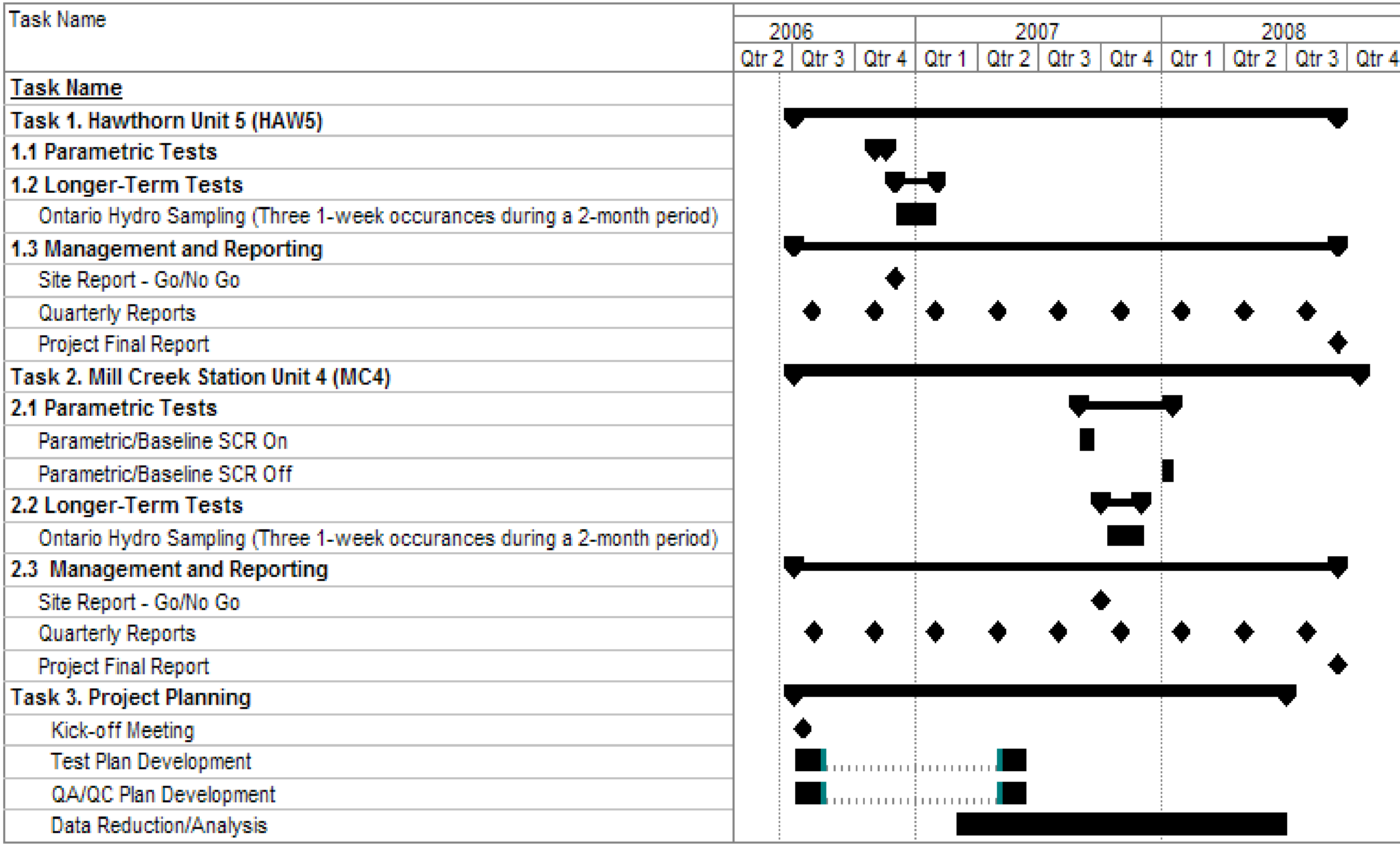
Task Structure/Schedule



Test Plan for Hawthorn

- Based on previous work the test plan for Hawthorn will concentrate on the following technologies:
  - SEA 1 Only
  - SEA 1 + PAC
  - SEA 2 T2 (SEA 2 + PAC)

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Parametric Test Plan for Hawthorn

Test #	Date	Hg Control Technology	SEA injection Location	Test	SEA 1 Coal Equiv.	SEA 2 lb/lb PAC	PAC lb/Macf
1	18-Sep	None	NA	Baseline			
	19-Sep	None	NA	Baseline			
2	20-Sep	SEA1 only (CaCl2)	Coal	Rate 1	800		
3	21-Sep	SEA1 only (CaCl2)	Coal	Rate 2	1000		
4	22-Sep	SEA1 only (CaCl2)	Coal	Rate 3	1200		
5	23-Sep	SEA1 + PAC	coal & prior to SDA	Rate 1	800		1 & 3
6	24-Sep	SEA1 + PAC	coal & prior to SDA	Rate 2	1000		1 & 3
7	25-Sep	SEA1 + PAC	coal & prior to SDA	Rate 3	1200		1 & 3
8	26-Sep	SEA2-T2 + PAC	prior to SDA	Rate 1		0.0125	1 & 3
9	27-Sep	SEA2-T2 + PAC	prior to SDA	Rate 2		0.05	1 & 3
10	28-Sep	SEA2-T2 + PAC	prior to SDA	Rate 3		0.1	1 & 3

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Mill Creek Unit 4

Sample Location	SCR Inlet, µg/Nm^3	SCR Outlet, µg/Nm^3	wet-FGD inlet, µg/Nm^3	Stack, µg/Nm^3	Reduction, %
With the SCR in Service					
Hg^p	0.02	0.03	0.00	0.00	
Hg^0	8.32	2.83	0.33	3.97	
Hg^{2+}	0.94	5.05	7.60	0.54	
Hg_{total}	9.27	7.90	7.93	4.50	**43.3**
With the SCR Bypassed					
Hg^p			0.07	0.05	
Hg^0			2.44	2.63	
Hg^{2+}			6.79	0.55	
Hg_{total}			9.30	3.23	**65.3**

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Mill Creek Unit 4 Cont.

- Mill Creek offers challenges with the SCR in service!
  - Possibly due to reactions with SO_3.
- SEA2 T2 will be primary technology tested at Mill Creek.

Mill Creek Test Plan SCR On

Test No.	Hg Control Technology	SEA Injection Location	Test
1	None	–	Baseline
2	SEA2 only	Prior to SCR	Rate 1
3	SEA2 only	Prior to SCR	Rate 2
4	SEA2 only	Prior to SCR	Rate 3
5	SEA2 only	Between the SCR and air heater	Rate 1
6	SEA2 only	Between the SCR and air heater	Rate 2
7	PAC only	–	1 lb/Macf
8	SEA2-T2 + PAC	Prior to SCR	Optimum SEA2-T2 + 1 lb/Macf PAC
9	SEA2-T2 + PAC	Prior to SCR	Optimum SEA2-T2 + 0.5 lb/Macf PAC
10	SEA2-T2 + PAC	Between the SCR and air heater	Optimum SEA2-T2 + 0.5 lb/Macf PAC
11–12	Contingency tests (potentially tests with B&W additive to prevent mercury reemission across the wet FGD)		

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Mill Creek Test Plan SCR Off

Test No.	Hg Control Technology	SEA Injection Location	Test
1	None	–	Baseline
2	SEA2 only	Determined from Part 1	Rate 1
3	SEA2 only	Determined from Part 1	Rate 2
4	SEA2 only	Determined from Part 1	Rate 3
5	PAC only	–	1 lb/Macf
6	SEA2-T2 + PAC	Determined from Part 1	Optimum SEA2-T2 + 1 lb/Macf PAC
7	SEA2-T2 + PAC	Determined from Part 1	Optimum SEA2-T2 + 0.5 lb/Macf PAC
8–9	Contingency tests (potentially tests with B&W additive to prevent mercury reemission across the wet FGD		

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Sampling Locations (Both Sites)

- Continuous Mercury Monitors – PCD inlet and stack for parametric tests. Stack only for long-term.
- Ontario Hydro – PCD inlet and stack for parametric tests and long term.
- Solid Samples – Daily coal, ash, slurry samples during parametric. Three per week during long term.
- EPA Method 5 – PCD inlet & stack?

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Project Budget

- Total Project Cost $2.99M
  - DOE - $2.2M
  - B&W - $400k
  - KCP&L - $100k (in-kind)
  - LG&E - $50k (in-kind)
  - Norit – 125k (in-kind)
  - SEA Supplier – $76k (in-kind)

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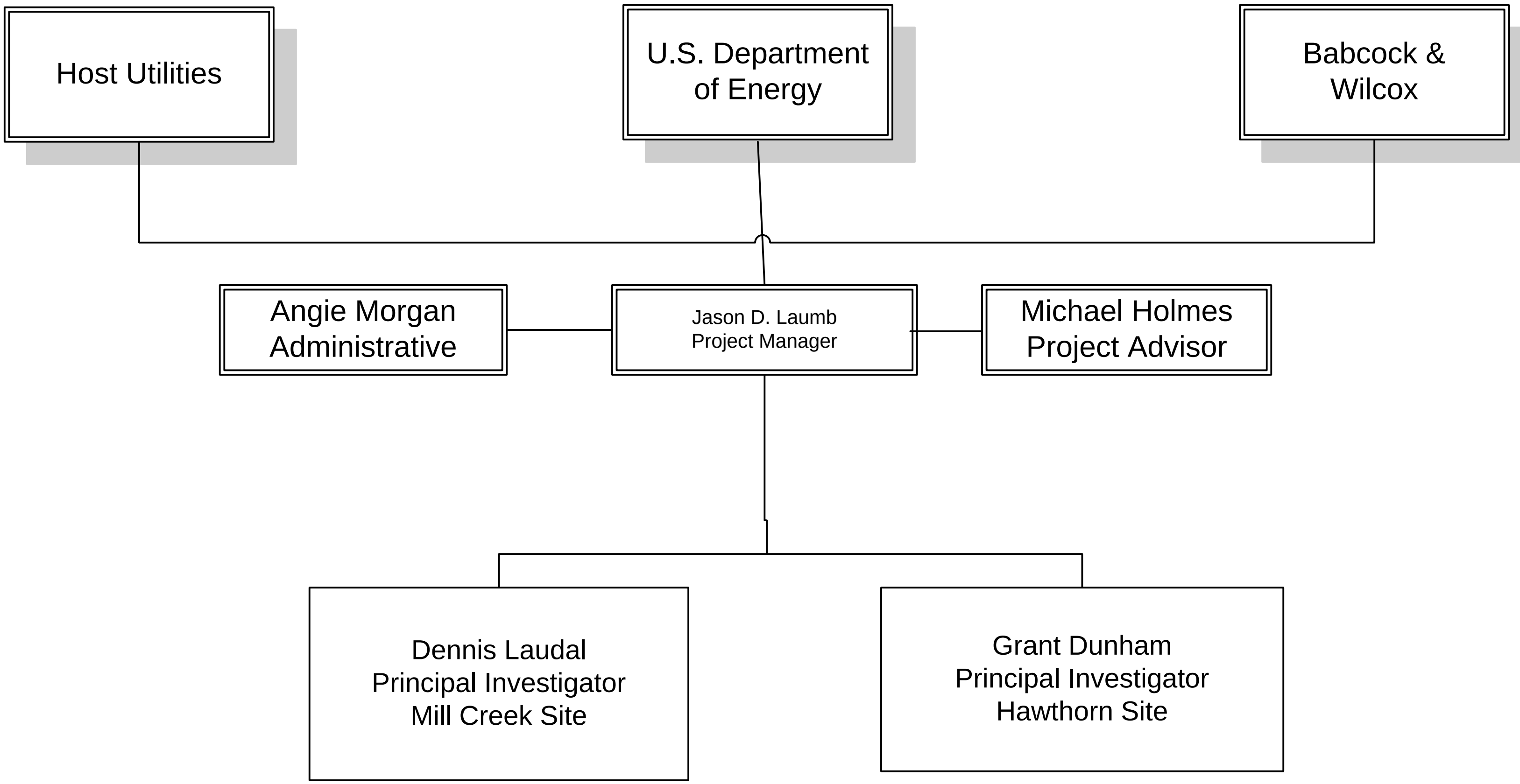
Personnel


Host Utilities
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Jason D. Laumb
Project Manager
Michael Holmes
Project Advisor
Dennis Laudal
Principal Investigator
Mill Creek Site
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Hawthorn Site